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Observational study on generations of plasma waves In the low latitude boundary layer

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In space around the earth, the solar wind plasmas interact with earth's magnetic fields, and it results in forming the magnetosphere. The night side region of the magnetosphere is called as Magnetotail after the tail-like structure of magnetic field lines. The low latitude region of the magnetotail is filled with hot plasmas. Since the region is formed as a sheet-like structure, we call it plasma sheet. The origin of the plasma sheet plasmas is believed to be the solar wind. However, much difference of plasma temperatures in plasma sheet and solar wind suggest the existence of some thermalization processes in the interface region between the plasma sheet and solar wind. This interface region is called Low Latitude Boundary Layer (LLBL). The GEOTAIL spacecraft observed that the both plasmas of solar wind and of magnetosphere origins are mixed in the LLBL. Therefore the LLBL is a key region in the geophysics in the view point of the plasma transportation from the solar wind into the magnetosphere. Therefore, it is very important to investigate the wave-particle interactions taking place in the LLBL, because kinetic energies are transported via plasma waves in the collisionless plasmas such as space plasmas. In the present paper, we focus on generation of plasma waves in the LLBL based on GEOTAIL observation data.

In the day-side LLBL, the GEOTAIL observed the mixture of solar wind ions and magnetosphere ions as well as low energy electrons thermalized along ambient magnetic field. We examined the relation between plasma waves and particles, and found that ion acoustic waves are observed when low energy electrons are thermalized along the ambient magnetic field. We proposed the current driven type instability as the excitation mechanism of ion acoustic wave in the day-side LLBL. We also surveyed the night-side LLBL from the viewpoint of plasma wave generations. We performed statistical analyses of the spatial distribution of the observed plasma waves. The GEOTAIL data used for the statistical analyses are obtained from January 1995 to March 2004. The results show the existence of the electromagnetic waves with their frequencies below 100Hz. Further, we found that they have the interesting feature that the intensities of these waves have the dawn-dusk asymmetry (see Figures 1 and 2).

We examined these low-frequency electromagnetic waves and found that they are whistler mode waves. In order to make clear how the dawn-dusk asymmetry is formed, we examined propagation directions of whistler mode waves. Using the Means method, we found that whistler mode waves are emitted from the magnetic equator region to the high latitude direction along the ambient magnetic field. This means that the source region of whistler mode waves is on the magnetic equator. By consulting plasma particle data and liner dispersion analyses, we concluded they are generated due to the electron temperature anisotropy. The relation of this generation mechanism and the dawn-dusk asymmetry is still unclear. However, the identification of the whistler mode wave generation is very helpful for considering a model for the dawn-dusk asymmetry.

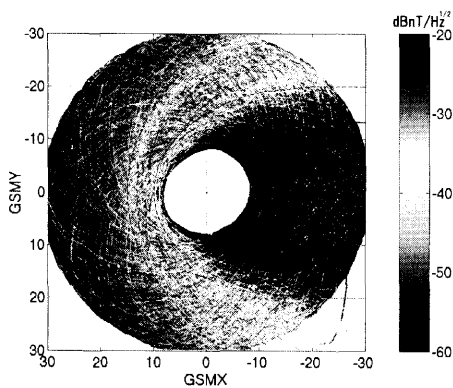


Figure 1: Spatial distributions of observed whistler mode waves.

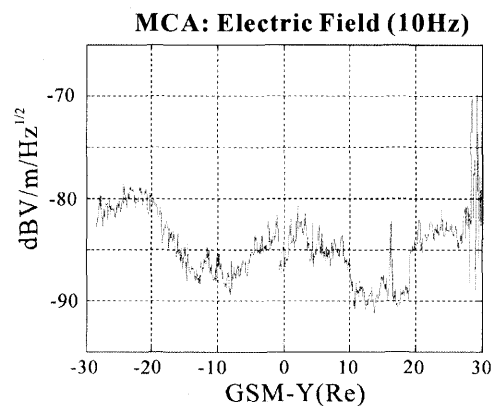


Figure 2: Dawn-dusk asymmetry of observed whistler waves. Electric field data of MCA 10Hz channel are used for the present statistical analyses.